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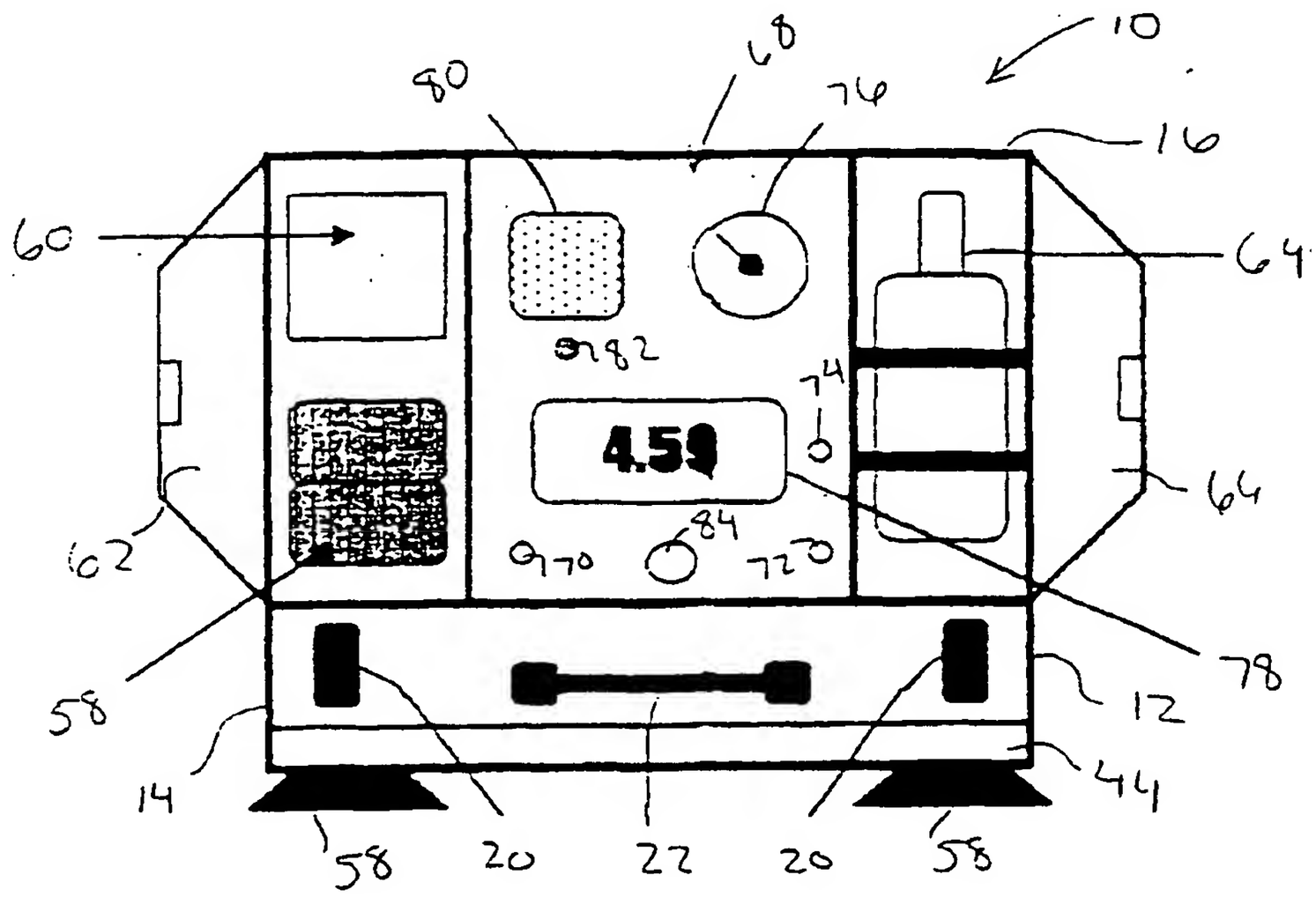
(54) Title: CPR TRAINING APPARATUS AND METHODS



(57) Abstract: A CPR training device comprises a portable carrying case having a control compartment and a compression compartment. A flexible compression platform is included in the compression compartment, and an inflatable bladder is positioned beneath the compression platform. An inflation device is provided to inflate the bladder with pressurized gas.

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CPR TRAINING APPARATUS AND METHODS

BACKGROUND OF THE INVENTION

This invention relates generally to the field of cardiopulmonary resuscitation (CPR), and in particular to CPR training. More specifically, the invention relates to equipment that may be used to train individuals in the performance of CPR.

Sudden cardiac arrest is a major cause of death throughout the world. This has prompted the development of a variety of CPR procedures to restore cardiac function for those suffering from cardiac arrest. Probably the most widely used CPR procedure is often referred to as standard CPR. With standard CPR, one or both hands are placed onto a patient's chest, and pressure is applied to repeatedly compress the chest with a generally constant rhythm. Another CPR technique is where a patient's chest may be actively lifted in an alternating manner with chest compression. This technique is often referred to as active compression/decompression (ACD) CPR. This technique is described generally in U.S. Patent Nos. 5,645,522, 5,551,420 and 5,692,498, the complete disclosures of which are herein incorporated by reference.

To enhance the benefits of CPR, it is desirable to perform the CPR procedure in such a manner so as to create certain intrathoracic pressures within the patient at certain time intervals. This may be accomplished, for example, by controlling the rate and distance of chest compressions and/or decompressions/elevations.

In some parts of the world, little or no training is provided relating to the proper manner of performing chest compressions. In other areas of the world, life-size mannequins have been utilized to train in the performance of CPR. One disadvantage of utilizing mannequins in training procedures is their large and bulky nature. As such, the mannequins are not easy to transport and thereby discourage their use in training. A life-size mannequin may also be relatively expensive, thereby further discouraging their use. Some mannequins may also not provide adequate feedback on the technique being used by a trainee, particularly when the trainee is using ACD CPR techniques where the chest is actively lifted in an alternating manner with chest compressions.

Hence, the invention is related to systems, devices and associated methods to provide more effective training for CPR procedures. The systems and devices are portable and easy to use to encourage their use in training a larger audience. The systems and devices of the invention are also useful with ACD CPR procedures, and provide relevant and timely feedback.

SUMMARY OF THE INVENTION

The invention provides systems, devices and methods for training potential rescuers in CPR procedures. In one embodiment, such a CPR training device comprises a portable carrying case having a control or operator feedback compartment and a compression compartment. A flexible compression platform or diaphragm is positioned over the compression compartment, and an inflatable or pre-inflated bladder disposed beneath the compression platform. A source of gas or other inflation device may be provided to permit the bladder to be inflated with pressured gas, if needed. In some cases, the bladder may be permanently inflated. Hence, the device may be used in CPR training by simply opening the carrying case and inflating the bladder if needed, to cause the compression platform to expand and assume the shape of the human chest or, more simply, to the shape of a rectangular cube. Conveniently, a diagram or figure may be included on the compression platform that depicts anatomical regions of a body, such as the thorax.

The training device may be used in association with an adjunctive CPR device that may be secured to the compression platform. Alternatively, the assistance device may be adhered to, coupled to, or placed in contact with the compression platform. In this way, the assistance device may be employed to press down on the compression platform as well to actively lift the compression platform, e.g., when performing ACD CPR.

In one aspect, the compression compartment includes a compression cavity into which a pressure, force or excursion sensor is placed. The compression cavity protects the pressure or other sensor from the inflated bladder while still permitting the sensor to sense the pressure or other characteristic within the compression compartment. A pressure display may also be provided on the control compartment to display the pressure or other characteristic sensed by the sensor. In this way, pressures may be monitored and displayed both during active compression and/or active lifting of the compression platform. In another aspect, a distance or excursion sensor is provided to sense the distance at which the

compression platform is raised and/or lowered relative to a baseline position. A distance display may be provided on the control platform to display the measured distance. In this way, a trainee is able to visualize the distance in which he or she is compressing the platform or actually lifting the compression platform. A force sensor may also be employed to sense the forces acting on the compression platform.

In one particular aspect, a spring-biased piston is disposed in the compression compartment, with the bladder surrounding the piston. With the bladder inflated, the pressure and tension on the bladder simulates the tension of a human thorax during chest compressions and the recoil properties of a human thorax during chest decompressions or elevations. The spring-biased piston provides for additional simulation of human thoracic tensions and recoil properties. Conveniently, the distance sensor may be configured to sense the distance traveled by the piston in both the downward and upward directions.

In another particular aspect, the CPR training device may further include a kneel plate or platform to kneel on that is movably coupled to the carrying case. The kneel plate may be moved between a storage position and a use or retracted position where the kneel plate extends from the compression compartment. In this way, the trainee may comfortably kneel in front of the carrying case to properly position the trainee relative to the compression platform as well to stabilize the carrying case during use, thereby preventing the carrying case from rising when performing chest decompressions. Optionally, suction feet may be provided on the bottom of the compression compartment to further assist in preventing the carrying case from rising during chest elevations.

In another aspect, the source of gas or inflation device may be disposed in the control compartment. Sources and devices to inflate the bladder include a tank of compressed air, a mechanical hand or foot pump, and electric air pump, the human lungs, and the like. In still another aspect, the control compartment and the compression compartment may be coupled by a hinge and mate together when the carrying case is closed. By providing a handle on the carrying case, the training device may be easily carried from one location to another.

The training device may also be provided with a power supply that is disposed in the control compartment. For example, the power supply may comprise a rechargeable battery to permit the training device to be used in the field. In still yet another aspect, a metronome may be provided to assist in the performance of regular compressions and/or

decompressions/elevations of the compression platform. An alarm may also be provided to produce audio and/or visual feedback if the compression platform is compressed or decompressed at a rate outside of a certain range and/or if the compression compartment is pressed or elevated more than a certain distance.

In another aspect, the device may include a lung bladder and a length of tubing to permit a rescuer to simulate patient ventilation while performing CPR. A sensor may be used to sense when a ventilation is provided so that feedback may be given as to the quality and timing of the ventilations.

The invention further provides a CPR training method that utilizes a CPR training device that is constructed in a manner similar to that previously described. According to the method, the training device is opened to gain access to the compression compartment and the control compartment. The bladder is then inflated to expand the compression platform to the morphology of a human thorax. The compression platform is then repeatedly pressed to simulate the performance of CPR on a human. Feedback is provided on the manner of pressing and lifting upward on the compression platform. Optionally, the compression platform may be actively lifted or elevated in an alternating manner with chest compressions. For example, an assistance device may be coupled to the compression platform and pressed and lifted in an alternating manner to simulate the performance of ACD CPR.

In one particular aspect of the method, the feedback may comprise information on the pressure within the compression compartment when the chest is being compressed and/or elevated. This pressure represents positive or negative intrathoracic pressures that would be created in a human patient when performing standard manual and ACD-CPR. An audio and/or visual alarm may be produced if the pressure within the compression compartment is outside of a certain range when pressing and/or lifting the compression platform. The feedback may also include information on the distance at which the compression platform is pressed or elevated. Optionally, an audio and/or visual alarm may be produced if the distance measured is outside a certain range when pressing and/or lifting the compression platform.

During training, the user may place one or more hands onto the compression platform in a manner similar to that used when performing standard CPR. As previously

described, an assistance device may be coupled to the compression platform, with an adjunctive CRP device being used to press or actively lift the compression platform.

Prior to performing CPR, a kneel plate may be retracted from the carrying case, with a trainee kneeling on the kneel plate to stabilize the device when performing CPR. Optionally, the trainee may actuate a metronome on the control compartment to assist the trainee in performing a regular rhythm of pressing and/or lifting.

In one aspect, the sensor may be connected to a computer interface to provide a permanent record of the quality of CPR performed, the duration of CPR training and to maintain a record of the names of individuals who have been trained and the length of their training. In another aspect, more than one sensor may be used to assess the excursion distance and the rate of excursion.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view of a CPR training device according to the invention.

Fig. 2 is a side view of the CPR training device of Fig. 1.

Fig. 3 is a top view of the CPR training device of Fig. 1.

Fig. 4 is a top view of a compression compartment of the CPR training device of Fig. 1 with a compression platform being removed.

Fig. 5 is a cross-sectional front view of the compression compartment of Fig. 4.

Fig. 6 illustrates a spring piston of the compression compartment of Fig. 5 as shown in an elevated position.

Fig. 7 illustrates the spring piston of Fig. 6 when in a compressed position.

Fig. 8 is a top view of a kneel plate of the training device of Fig. 1 when in an extended position.

Fig. 9 illustrates the kneel plate of Fig. 8 in a retracted position.

Fig. 10 is a more detailed view of a control panel of the CPR training device of Fig. 1.

Fig. 11 illustrates a flow chart setting forth the steps of one method for training in the use of CPR according to the invention.

Fig. 12 is a top view of an alternative training device according to the invention.

Fig. 13 is a cross sectional side view of the training device of Fig. 12.

DESCRIPTION OF THE SPECIFIC EMBODIMENTS

The invention provides devices, systems and methods for training, educating and tracking individuals in the performance of CPR. The invention may be utilized in conjunction with most generally accepted CPR methods, including standard CPR where the rescuer places his or her hands on the chest and repeatedly presses down to compress the chest. The invention is also useful with ACD CPR techniques where the chest is lifted in an alternating manner with chest compressions. When training in the use of ACD CPR, the invention may utilize an assistance device to assist in actively lifting the chest in an alternating manner with chest compressions. For example, one type of assistance device that may be used is a Cardiopump™ assistance device, commercially available from Ambu International. Such an assistance device is also described in U.S. Patent No. 5,645,522, the complete disclosure of which is herein incorporated by reference. Other CPR methods that involve chest compressions may be utilized in conjunction with the invention.

The invention provides training in CPR techniques by simulating the thoracic tensions and recoil properties of a human thoracic cage during CPR compression and, optionally, decompression cycles. The invention also provides the trainee with immediate feedback regarding the proper method of performing CPR. In this way, the invention provides significant advantages over prior art CPR training mannequins due to the compact/portable construction and the ability to simulate intrathoracic cage pressures during both compression and decompression cycles and the ability of interface a computer for providing feedback and tracking training results.

The invention may also provide the ability to record and store information regarding an individual's performance of CPR. This may be accomplished, for example, by providing a computer interface to permit the training device to be coupled to a computer. Alternatively, the training device could include an on board computer to record such information. The stored information may include information on how the trainee presses and/or lifts during CPR training, the duration of training, the coordination of breathing with pressing and/or lifting, the application of a defibrillating shock, and the like.

To simulate thoracic tensions and recoil properties of a human thoracic cage, the invention in one embodiment provides an inflatable (or pre-inflated) bladder that is

disposed beneath a flexible cover or compression platform. The bladder is inflated to flex the cover until assuming the morphology of a human thoracic cage. The trainee then performs CPR by pressing down on the compression platform and, optionally, actively lifting the compression platform as if the trainee were performing ACD CPR on a human patient. The pressure produced within the compression compartment while performing CPR is displayed in real time. In this way, the trainee is able to visualize the positive and negative intrathoracic pressures created while performing CPR. The invention may also be employed to visually display in real time the distance of compression and/or elevation while performing CPR. This information may be obtained from an excursion sensor. If the pressures generated or the distance moved exceeds certain ranges, an alarm may be produced to notify the trainee of the improper technique.

In one optional aspect, a breathing tube may extend from the training device in such as way as to simulate a patient's neck. Conveniently, the tube may be expandable and compressible for easy storage when not in use. The end of the tube may include a mouthpiece where the trainee may place their mouth to simulate mouth to mouth resuscitation. Alternatively, the end of the tube may include an air bag that is squeezed by the trainee. Optionally, a flow sensor may be provided in the tube to sense when the trainee delivers a volume of a respiratory gas. This information may be sent to a controller to maintain a record of the timing of delivery (particularly in relation to chest compressions), the duration, the volume, and the like.

Another feature of the invention is that the training device may be housed in a portable carrying case. In this way, the training device may conveniently be carried to training locations. When ready to begin training, the carrying case is placed on a flat surface, opened, and the bladder is inflated.

Referring now to Figs. 1 and 2, one embodiment of a CPR training device 10 will be described. Training device 10 comprises a portable carrying case 12 that is constructed of a compression compartment 14 and a control compartment 16. Carrying case 12 may be constructed of a generally rigid material and may have the overall size and shape of a conventional briefcase. In this way, training device 10 is compact in nature, thereby providing portability during travel and a reduction in training space requirements.

Compression compartment 14 is coupled to control compartment 16 by a hinge 18 to permit carrying case 12 to be opened and closed in a manner similar to a

conventional briefcase. Conveniently, latches 20 may be provided to latch control compartment 16 to compression compartment 14 when in the closed position. A handle 22 may also be provided to facilitate carrying of carrying case 12.

Carrying case 12 may optionally include a power supply interface 13 to permit device 10 to be coupled to an external power source. Further, a computer interface 15 may be provided to permit device 10 to be coupled to an external computer. In this way, various data obtained using device 10 may be recorded and processed. Optionally, interface 15 may be used to permit device 10 to be coupled to any type of network, such as the internet, to facilitate data transfer.

As also shown in Fig. 3, compression compartment 14 houses a compression platform 24. Compression platform 24 may be constructed of a durable and flexible material that can withstand repeated compressions and elevations. Optionally, compression platform 24 may include a diagram or image 26 of a human chest, thoracic cage, or other anatomical depictions to assist in proper positioning of an assistance device or the trainer's hands while performing CPR. Compression platform 24 may be sealed to compression compartment 14 to create an enclosed air-tight cavity beneath compression platform 24. By providing a sealed environment within compression platform 24, the pressure anywhere within compression platform 24 may be measured when performing chest compressions and decompressions as described below in order to provide positive and negative "intrathoracic" pressure measurements.

As best shown in Figs. 4 and 5, compression compartment 14 includes an inflatable bladder 28 that is housed beneath compression platform 24. Bladder 28 may also be made from a durable and flexible material that can withstand repeated inflations prior to use, compressions and expansions during use, and deflation after use. When inflated, bladder 28 expands compression platform 24 to the morphology of a human thorax. Fig. 2 illustrates compression compartment 14 when bladder 28 has been inflated. When inflated, bladder 28 may be used to simulate the tension of a human thorax during chest compressions and the recoil properties of a human thorax during chest decompressions or elevations.

A spring-loaded piston system 30 may also be placed within compression compartment 14 to provide additional simulation of human thoracic tensions and recoil properties. Piston system 30 comprises a housing 32 that houses a spring 34. Piston system 30 further includes a translatable piston member 36. Piston system 30 is centrally located

within compression compartment 14, with bladder 28 surrounding piston system 30. When compression platform 24 is pressed downward, piston member 36 is moved downward to compress spring 34 as illustrated in Fig. 7. When the downward pressure is released from compression platform 24, the pressure within bladder 28, along with spring 34, forces compression platform 24 back to its normal position as illustrated in Fig. 6. When platform 26 is pulled upward, such as with an adjunctive CPR device, the spring loaded piston is extended upward. A sensor (not shown) may be employed to determine the extent of compression or extension of the spring relative to the normal position. This information may then be sent to the controller.

As best shown in Fig. 5, a compressed air inflate/deflate port 38 is provided in compression compartment 14 to permit bladder 28 to be inflated and deflated. As described in greater detail hereinafter, a source of compressed gas may be coupled to port 38 to permit bladder 28 to be inflated. Alternatively, bladder 28 may be inflated by providing a mechanical hand or foot pump, an electric air pump, or by blowing up bladder 28 by mouth.

Compression compartment 14 further includes a pressure sensing port 40 through which a pressure sensor may be positioned. A shield 41 is provided within the compression compartment to form a compression cavity 43. Shield 41 protects the pressure sensor from bladder 28 during the compression phase while permitting compression cavity 43 to remain in fluid communication with the rest of the compression compartment 14. Since compression platform 24 (see Fig. 2) creates an air tight seal with compression compartment 14, the pressures measured by the pressure sensor within compression cavity 43 are identical to the pressures within compression compartment 14. Hence, the pressure sensor may be used to measure the amount of positive intrathoracic pressure during chest compressions and the amount of negative intrathoracic pressure during chest decompressions and elevations. A variety of pressure sensor or force transducing devices may be employed to measure the pressure in this manner. As described in greater detail hereinafter, the pressure sensing device may be coupled to a pressure gauge or other type of display to visually display the sensed pressure.

Also housed within housing 32 is a linear variable differential transformer (LVDT) 42 to provide the trainee with the thoracic distance traveled during compression, decompression or elevation cycles as illustrated in Figs. 6 and 7. More specifically, LVDT 42 measures the distance traveled by piston member 36 as compression platform 24 is

pressed or lifted. Although a LVDT is shown, it will be appreciated that other devices may be employed to measure the linear distance traveled by compression platform 24 during compression or elevation cycles, including encoders, optical sensors, magnetic switches, and the like.

As best shown in Figs. 2, 8 and 9, training device 10 further includes a kneel plate 44 which is provided to allow a trainee to comfortably kneel in front of carrying case 12 when performing CPR. When kneeling on kneel plate 44, carrying case 12 is stabilized and prevents compression compartment 14 from being lifted during chest elevations. Kneel plate 44 may optionally include a foam or other resilient surface to provide padding for the trainee's knees.

Kneel plate 44 is positioned beneath compression compartment 14 and is housed within a case frame 46. Housed in case frame 46 is a pair of support rails 48 to assist and guide kneel plate 44 when it is moved between an extended position (see Fig. 8) and a retracted position (see Fig. 9). A scissors mechanism 50 may also be provided to give additional stability and to provide assistance when extending and retracting kneel plate 44. Optionally, a load support rod 52 may be coupled to kneel plate 44 to facilitate coupling between scissors mechanism 50 and kneel plate 44. Conveniently, knee pads 52 may be provided on kneel plate 44 to provide a comfortable resting place for the trainee's knees. Optionally, a knob 56 may be provided to assist the user in extending and retracting kneel plate 44. As best shown in Figs. 1 and 2, carrying case 12 may optionally include suction feet 58 on compression compartment 14 to prevent carrying case 12 from rising during chest elevations.

Referring back to Fig. 1, construction of control compartment 16 will be described. Control compartment 16 includes a rechargeable power source 58 to provide electrical current to the various electrical components within training device 10. For example, power source 58 provides power to a circuit board 60 having a controller that in turn is employed to control the various sensors, gauges, alarms, displays, metronome, and the like, of training device 10. The controller may optionally be coupled to an external computer using interface 15 as previously described. In this way, a permanent record relating to the rescuer's performance may be made. For example, the controller may be used to generate and transmit data tracking the timing and extent of compression and/or decompression, the generated pressures, the duration of training, and the like. Optionally, the attached (or

integrated) computer may include software to permit the entry of the trainee's name so that the transmitted information may be linked to a specific trainee. In cases where the training device also permits the simulation of ventillations and/or defibrillating shocks, this information may also be sent to the external computer. In this way, feedback may further be provided on the timing and length of ventilations as well as the application of the defibrillating shock. The computer may also be used to produce a graphical display on a display screen summarizing the evaluation. For example, the display may include a graph showing when the compressions/decompressions and ventillations were performed. This information may be superimposed on, or placed adjacent to, a graph having recommended actuation times. In a similar manner, graphical depictions may be produced showing the magnitude and duration of compressions/decompressions and ventilations.

Conveniently, a door 62 is provided to enclose circuit board 60 and power source 58. The opposite side control compartment 16 includes an optional compressed air tank 64 that is coupled to port 38 (see Figs. 4 and 5) to supply compressed air to bladder 28 to inflate the bladder as previously described. Conveniently, a door 66 is provided to enclose air tank 64. Although shown with an air tank, it will be appreciated that other inflation equipment may be used including a mechanical hand or foot pump, an electric air pump, and the like. Further, in some cases bladder 28 may be inflated by blowing up bladder 28 by mouth, thereby eliminating the need for an inflation device.

As also shown in Fig. 10, control compartment 16 includes a display panel 68. Display panel 68 includes a power switch 70 that is movable between an on and an off position. When turned to the on position, power from power source 58 is available to the various electrical components of training device 10. An inflate/deflate switch 72 is also provided on display panel 68. When switch 72 is moved to the inflate position, compressed air from air tank 64 is supplied to bladder 28 to inflate the bladder. When moved to the deflate position, the air within bladder 28 is released through port 38 so that carrying case 12 may be closed and transported. A calibrate switch 74 is also provided to calibrate the system prior to performing CPR. More specifically, after bladder 28 is inflated, calibration switch is pressed to calibrate the distance sensor within compression compartment 14 to a baseline or starting value.

A pressure gauge 76 is provided on display panel 68 and is coupled to circuit board 60 which in turn is coupled to the pressure sensor within compression compartment 14.

In this way, the pressure within compression cavity 43 may be monitored and displayed in real time. Hence, as the trainee kneels in front of display panel 68, the user is able to see the positive and negative intrathoracic pressures created when performing CPR. Similarly, a compression/decompression gauge 78 is provided to display the distance at which compression platform 24 is pressed or lifted relative to the calibrated value. It will be appreciated that gauges 76 and 78, as well as any other feedback mechanisms, may be entirely analog gauges, entirely digital gauges, or a combination of either technology.

Display panel further includes a speaker 80 that is electrically coupled to circuit board 60. In this way, an audible alarm may be produced if the pressures created within compression cavity 43 or the distance traveled by compression platform 24 are outside of certain ranges. Merely by way of example, an alarm may be produced if the measured force is greater than about 300 N to about 400 N during chest compressions and exceeds about –200 N to about –300 N during chest decompressions or elevations. Similarly, an alarm may be produced if the distance compressed is greater than about 6 cm to about 8 cm during chest compressions or exceeds about 4 cm to about 8 cm when performing chest decompressions or elevations. It will be appreciated that these ranges are contingent upon the patient size as described below. Optionally, a flashing light 82 may be provided as an additional alarm.

Circuit board 60 may also include circuitry to provide the function of an electrical metronome. In this way, a regular rhythm may be produced with speaker 80 to assist the trainee in performing regular chest compressions and/or elevations. Further, display panel 68 may include a patient type switch 84 which allows the trainee to select a particular patient build, i.e., small, medium, or large. This setting is used to determine appropriate pressure and distance ranges that must be exceeded before an alarm will be produced as previously described.

Although device 10 is shown with various sensors and displays, it will be appreciated that simplified versions of device 10 are also possible. For example, training device 10 may be constructed of a carrying case, a bladder that is manually inflatable and deflatable, and a kneel plate.

In another alternative, device 10 may include appropriate electrical shielding so that a defibrillating shock may be applied to compression platform 24 without damaging the electrical components or injuring the trainee. When modified in such a manner, the

training device may include a ground plate and an adjunctive CRP device having defibrillating electrodes to supply the defibrillating shock. Types of adjunctive CPR device that may be used (and modified to include electrodes, if needed) are described in U.S. Patent Nos. 5,454,779 and 5,645,552, and in copending U.S. Patent Application Serial Nos. 09/197,286, filed 11/20/98, 09/095,916, filed 6/11/98 and 09/315,396, filed 5/20/99, the complete disclosures of which are herein incorporated by reference.

Referring now to Fig. 11, one training method utilizing CPR training device 10 will be described. Initially, the user carries the carrying case to a smooth, flat surface and engages the suction feet. The carrying case is then opened as illustrated in step 86 and kneel plate 44 is extended as shown in step 88. Power switch 70 is then turned to the "on" position as shown in step 90 and switch 72 is switched to the "inflate" position to inflate bladder 28. Circuit board is preferably programmed so that a predetermined amount of gas is supplied to bladder 28. Once the bladder is inflated, the user presses calibrate button 74 to calibrate the training device as illustrated in step 92. When calibrate button 74 is pressed, the compression/decompression gauge 78 is configured to read zero. The user then selects the particular patient type using switch 84. Conveniently, pressure gauge 76 may be configured to read zero when the bladder is inflated to the proper volume. In some cases, pressure gauge 76 may also be configured to be calibrated when calibrate button 74 is pressed.

As shown in step 94, the user may optionally couple an assistance device to compression platform 24. The user may then kneel on kneel plate 44, with the user's knees resting on knee pads 54. Standard CPR or ACD CPR may then be performed as if the trainee were practicing on a real patient as shown in step 98. Speaker 80 may be employed to perform a metronome function to assist the user in performing regular chest compressions or elevations as shown in step 96. Optionally, light 82 may be lighted according to the same rhythm produced by speaker 80. When placing the user's hands or the assistance device onto compression platform 24, diagram 26 may be referred to ensure proper placement.

When performing CPR, the user may observe the depth of compression or height of elevation and the produced pressure by evaluating gauges 78 and 76, respectively. This permits the user to attempt to stay within predetermined guidelines determined by CPR standards for the appropriate patient frame size. Audio and/or visual alarms may be produced by speaker 80 or light 82 if the user exceeds the guideline parameters as shown in step 100. Optionally, as shown in step 102, feedback on the trainee's performance may be stored using

an external computer (or an onboard computer, if provided). As another option step, simulated ventilations may periodically be provided and appropriate feedback generated and displayed.

Referring now to Figs. 12 and 13, and alternative embodiment of a training device 110 will be described. Device 110 is similar to device 10 and may conveniently use similar sensors, a similar controller, a similar kneel plate, a similar compression platform, among other components. Device 110 comprises a carrying case 112 having a compression platform 114. Held within carrying case 112 is a thoracic cavity bladder 116 that may be inflated and deflated through an inflate/deflate port 118. A pressure sensing port 120 is also provided to permit pressure measurements to be taken in a manner similar to that described with device 10. A spring housing 121 houses a spring piston 122 that is compressed and extended when performing CPR training in a manner similar to device 10.

Device 110 further includes a lung bladder 124 that is positioned on a lung bladder mount platform 126. A lung inflate/deflate port 128 is coupled to lung bladder 124 to permit inflation and deflation of bladder 124. Bladder 124 is used to simulate a patient's lungs. Coupled to port 128 is a length of collapsible tubing 130 having a mouthpiece 132. These components are configured to simulate a patient's neck a mouth so that a trainee may practice ventilating the patient using mouth to mouth resuscitation techniques. Alternatively, a ventilatory bag may be used in place of mouthpiece 132 to permit the trainee to practice ventilations by squeezing the bag. Conveniently, tubing 130 is collapsible and/or removable to facilitate storage of device 110.

The controller within device 110 may be used to generate a signal to indicate when to provide ventillations in relation to chest compressions. Further a pressure or other sensor may be used to sense the flow of gases and the pressure within bladder 124. In this way, feedback may be provided as to the proper performance of ventillations in connection with a CPR procedure. As with other embodiments, this information may be transmitted to an external or onboard computer.

The invention has now been described in detail for purposes of clarity and understanding. However, it will be appreciated that certain changes and modifications may be practiced within the scope of the appended claims. For example, in some cases the training device may include all mechanical components so that a power supply or electronics are not needed. For instance, a spring strain gauge may be employed to assess the extent of

compression and decompression. Also, a mechanical pump may be used to inflate the bladder.

WHAT IS CLAIMED IS:

1. A CPR training device, comprising

a portable carrying case having a control or feedback compartment and a compression compartment;

a flexible compression platform associated with the compression compartment; and

a bladder disposed beneath the compression platform.

2. A device as in claim 1, wherein the compression platform is sealingly coupled to the carrying case.

3. A device as in claim 1, further comprising an inflation device that is adapted to inflate the bladder.

4. A device as in claim 1, further comprising a pressure sensor disposed to sense the pressure within the compression compartment, and a pressure display on the control compartment to display the pressure sensed by the pressure sensor.

5. A device as in claim 1, further comprising a force or excursion sensor to measure the force on the bladder or the excursion of the compression platform.

6. A device as in claim 1, further comprising a spring-biased piston disposed in the compression compartment such that the bladder surrounds the piston.

7. A device as in claim 6, further comprising a distance sensor disposed to sense the distance traveled by the piston, and a distance display on the control or feedback compartment to display the distance traveled by the piston.

8. A device as in claim 1, further comprising a kneel plate movably coupled to the carrying case, the kneel plate being movable between a storage position and a use position where the kneel plate extends from the compression compartment.

9. A device as in claim 1, further comprising an image on the compression platform depicting anatomical regions of a body.

10. A device as in claim 1, further comprising suction feet coupled to the compression compartment.

11. A device as in claim 1, wherein the inflation device is disposed in the control compartment.

12. A device as in claim 1, wherein the control or feedback compartment and the compression compartment are coupled by a hinge and mate when the carrying case is closed.

13. A device as in claim 1, further comprising a power supply disposed in the control or feedback compartment.

14. A device as in claim 1, further comprising a power supply interface to permit the device to be coupled to an external power source.

15. A device as in claim 1, further comprising a metronome to assist in the performance of regular compressions of the compression platform.

16. A device as in claim 1, further comprising an alarm to produce an audio and/or visual signal if the compression platform is compressed at a rate outside of a certain range and/or if the compression platform is pressed more than a certain distance.

17. A device as in claim 16, wherein the alarm is further configured to produce the signal if a pressure or force value produced by a rescuer when compressing the compression platform is exceeded.

18. A device as in claim 1, further comprising a feedback system to provide visual feedback on the manner of compressions and decompressions of the compression platform.

19. A device as in claim 1, further comprising at least one sensor to measure the effectiveness of compression and decompression of the compression platform when using a hand held active compression/decompression CPR device.

20. A device as in claim 1, further comprising a lung bladder disposed beneath the compression platform, and a length of tubing to permit gases to be introduced into the lung bladder.

21. A device as in claim 20, further comprising a sensor to sense when the gases are introduced.

22. A CPR training system, comprising:

a CPR training device comprising a portable carrying case having a control compartment and a compression compartment, a flexible compression platform in the compression compartment, and a bladder beneath the compression platform; and

an adjunctive CPR device that is adapted to be placed onto the compression platform to permit the compression platform to be pressed and lifted by a trainee.

23. A system as in claim 22, wherein the compression platform is sealingly coupled to the carrying case.

24. A system as in claim 22, further comprising an inflation device that is adapted to inflate the bladder, and a feedback system to provide visual and/or audio feedback on the manner of pressing down and/or lifting up.

25. A CPR training method comprising:

providing a CPR training device comprising a carrying case having a compression compartment and a control compartment, a flexible compression platform in the compression compartment, and a bladder beneath the compression platform;

inflating the bladder with a gas;

repeatedly pressing and lifting the compression platform in an alternating manner to simulate the performance of active compression/decompression CPR; and

providing feedback on the manner of pressing and lifting the compression platform.

26. A method as in claim 25, wherein the training device further includes a pressure sensor, and wherein the feedback providing step comprises displaying the pressure

within the compression compartment as measured by the pressure sensor on the control compartment.

27. A method as in claim 26, wherein the training device further includes a force sensor and an excursion sensor, and wherein the feedback providing step comprises displaying the force applied to the compression compartment and the extent of travel of the compression platform as measured by the force and the excursion sensors on the control compartment.

28. A method as in claim 25, further comprising producing an audio and/or visual alarm if the pressure within the compression compartment is outside a certain range when pressing or lifting the compression platform.

29. A method as in claim 25, wherein the training device further includes a spring-biased piston, and further comprising measuring the distance traveled by the piston when pressing or lifting the compression platform and displaying the measured distance on the control compartment.

30. A method as in claim 29, further comprising producing an audio and/or visual alarm if the distance measured is outside a certain range during pressing of the compression platform.

31. A method as in claim 25, wherein the pressing steps comprises placing a hand on the compression platform and pressing downward.

32. A method as in claim 25, wherein the pressing and lifting step comprises placing an adjunctive CPR assistance device onto the compression platform and pressing and lifting the CPR assistance device in an alternating manner.

33. A method as in claim 25, further comprising inflating the bladder with a tank of pressurized gas.

34. A method as in claim 25, further comprising retracting a kneel plate from the carrying case and kneeling on the kneel plate when pressing and lifting the compression platform.

35. A method as in claim 25, wherein the compression compartment and the control compartment are coupled by a hinge, and further comprising opening the carrying case about the hinge to gain access to the compression platform.

36. A method as in claim 25, wherein the carrying case includes a handle, and further comprising carrying the carrying case by the handle.

37. A method as in claim 25, wherein the training device further includes a metronome, and further comprising actuating the metronome to assist a trainee in performing a regular rhythm of pressing and lifting.

38. A method as in claim 25, wherein the feedback providing step comprises recording the timing, duration and/or magnitude of pressing and lifting of the compression platform.

39. A method as in claim 38, further comprising recording the feedback information in a computer, and graphically displaying the feedback information on a display screen of the computer.

40. A method as in claim 39, further comprising displaying recommended values of the manner of pressing and lifting on the display screen.

41. A CPR training device comprising:

a housing defining an interior and having an open top end;

a flexible compression plate positioned across the open top end; and

an inflatable bladder within the interior, wherein the bladder is inflatable to cause the compression plate to acquire the morphology of a human thorax.

42. A device as in claim 41, wherein the compression plate is sealingly coupled to the housing.

43. A device as in claim 41, further comprising a spring-biased piston in a center of the interior, with the bladder surrounding the piston.

44. A CPR training method, comprising:

inflating a bladder that is enclosed within a compartment covered by a platform;

pressing down on the platform and actively lifting up on the platform in an alternating manner;

measuring the pressure in the compartment when pressing down and lifting; and

displaying the measured pressure as the platform is being pressed and lifted.

45. A method as in claim 44, further comprising measuring the distance that the platform is compressed and actively lifted, and displaying the measured distances.

46. A method as in claim 44, wherein the platform is sealingly coupled to the compartment.

47. A method as in claim 44, further comprising providing a lung .bladder disposed beneath the compression platform, further comprising periodically supplying a gas to the lung bladder after the pressing step, and further comprising measuring when the gas is supplied.

48. A CPR training device, comprising

a housing defining an interior and having an open top end;

a flexible compression plate positioned across the open top end;

a thoracic cavity bladder within the interior;

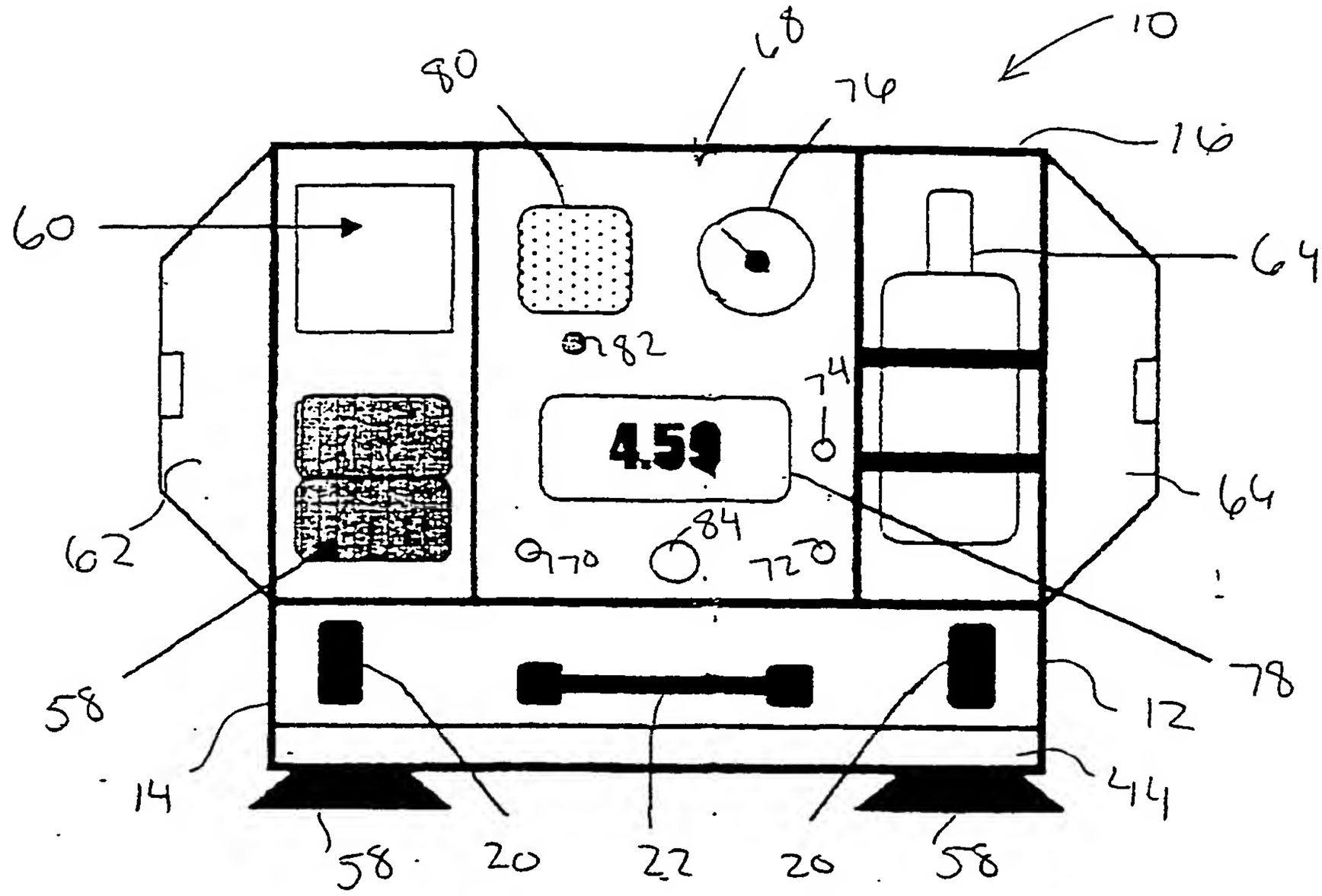
a lung bladder disposed within the interior; and

a lung bladder inflation port to permit gases to be introduced into the lung bladder.

49. A device as in claim 48, wherein the compression plate is sealingly coupled to the housing.

50. A device as in claim 48, further comprising a length of tubing coupled to the inflation port, and a mouthpiece coupled to the length of tubing.

FIG.1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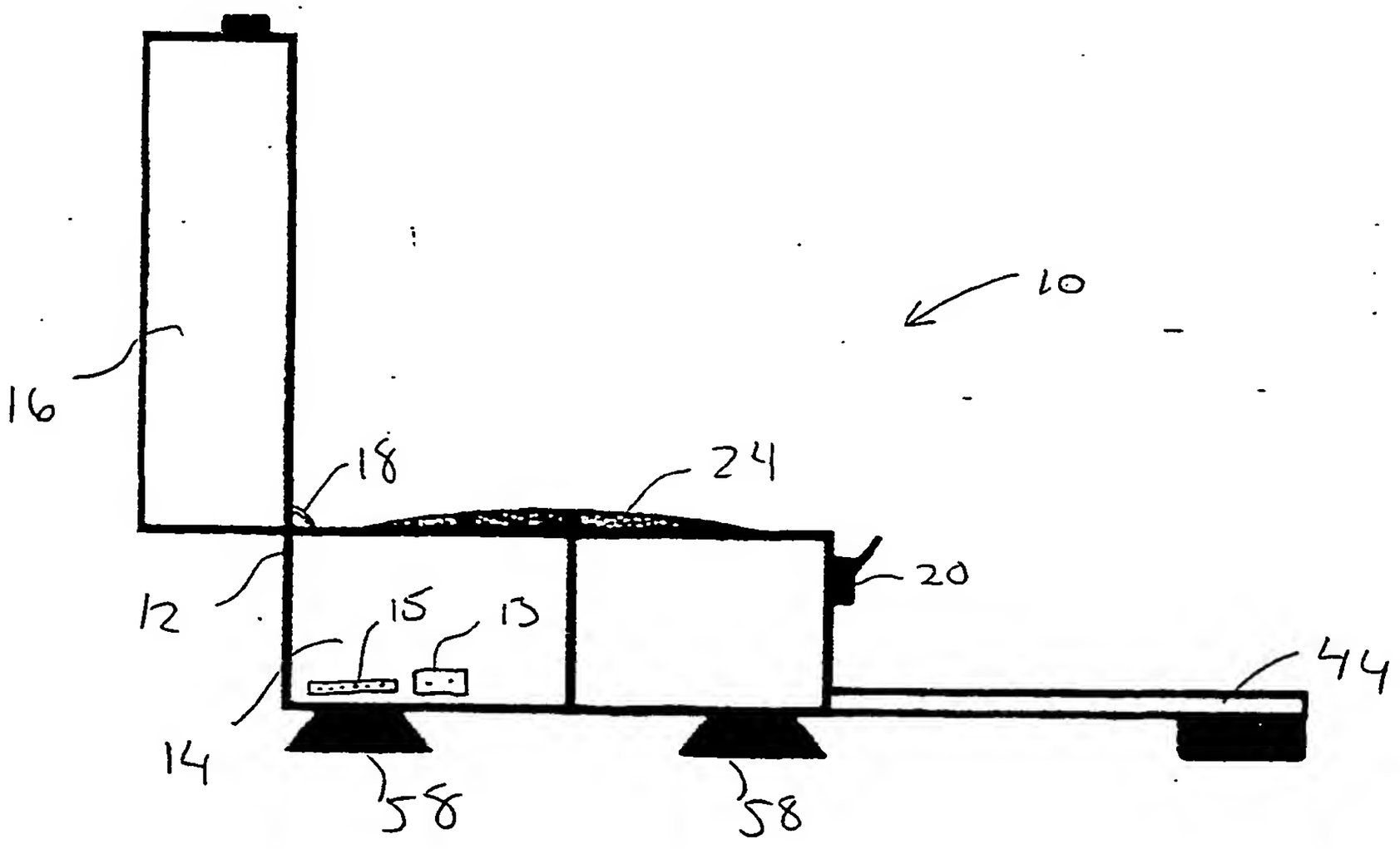
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FIG.2

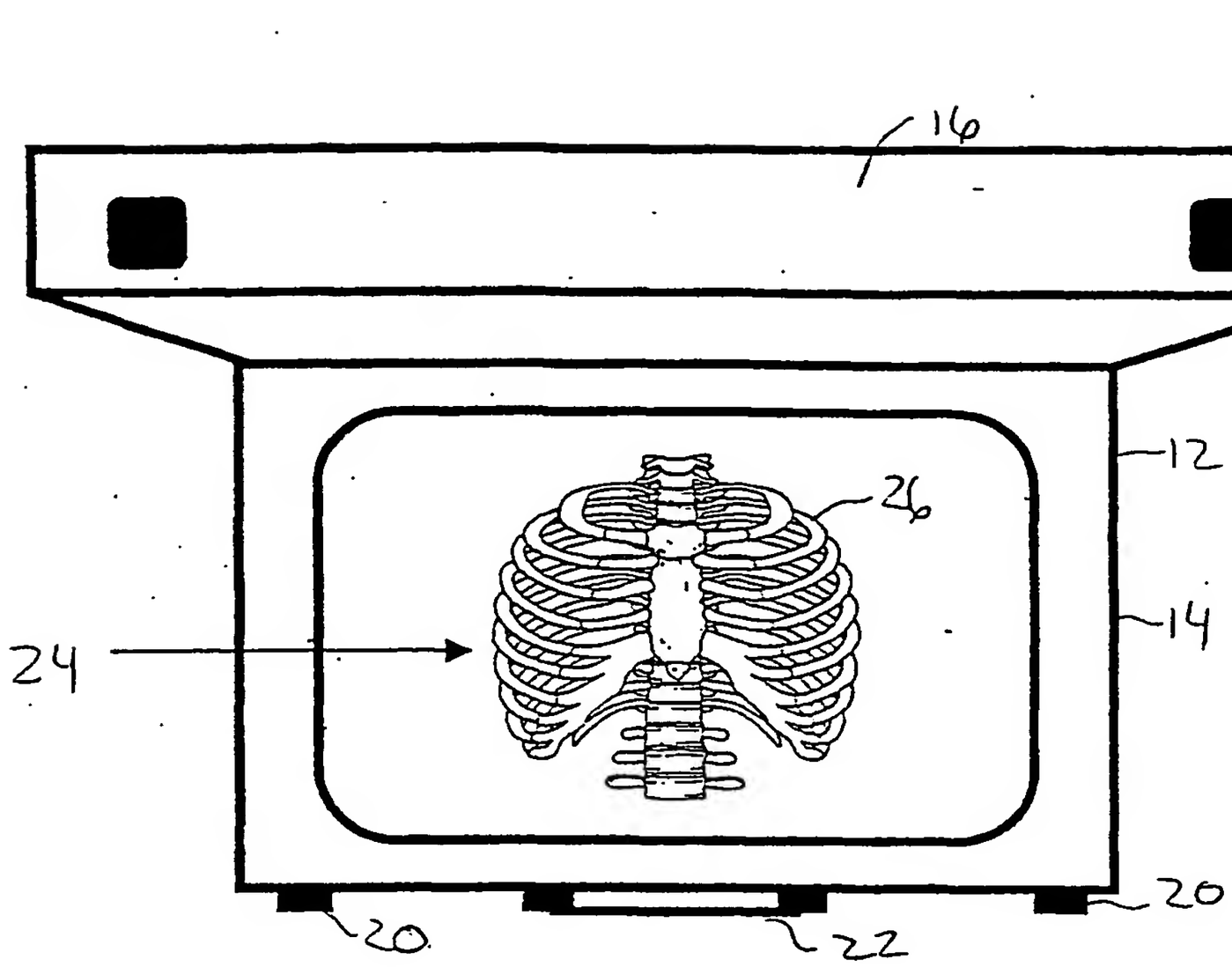


FIG. 3

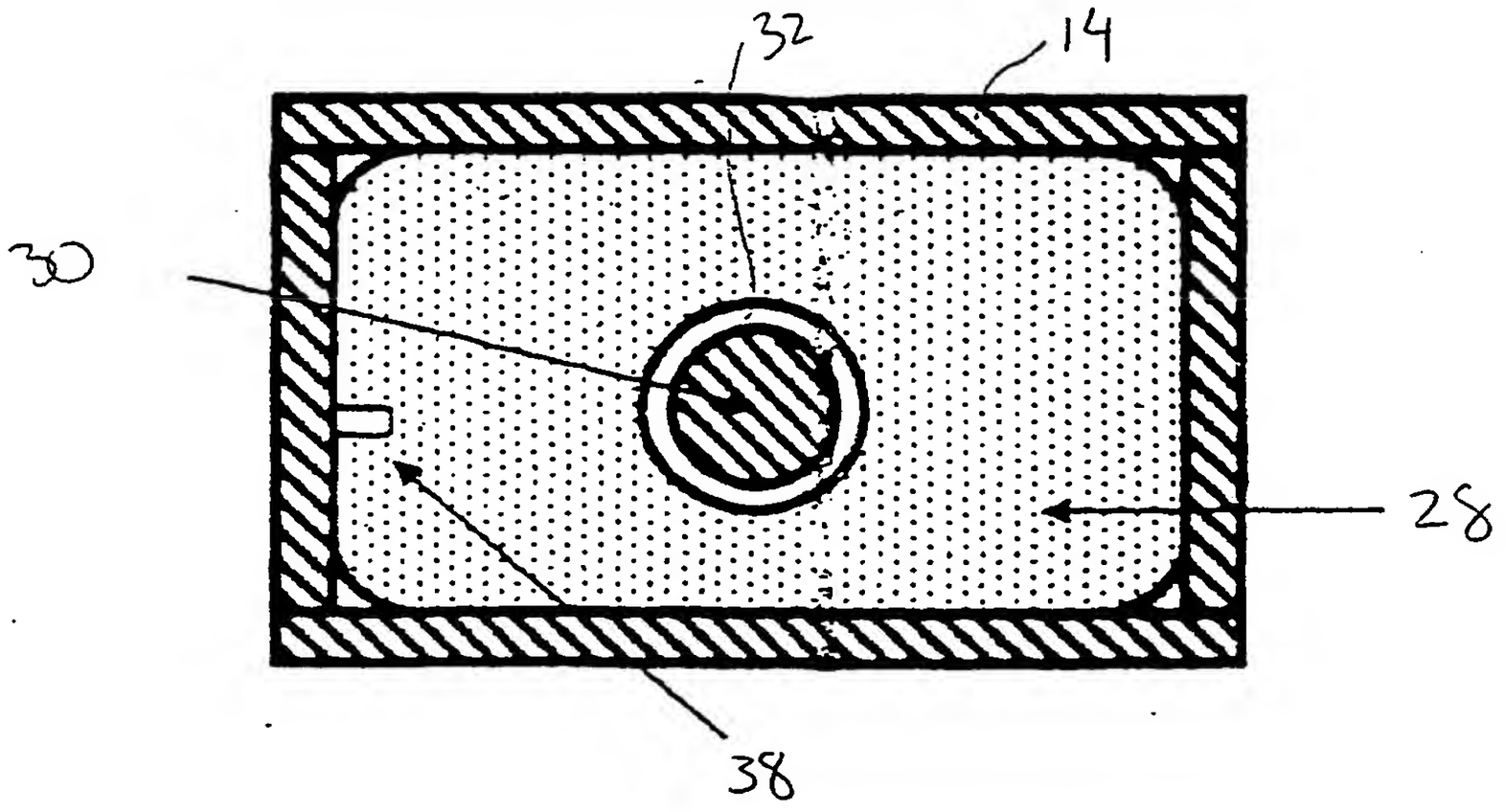


FIG. 4

FIG. 5

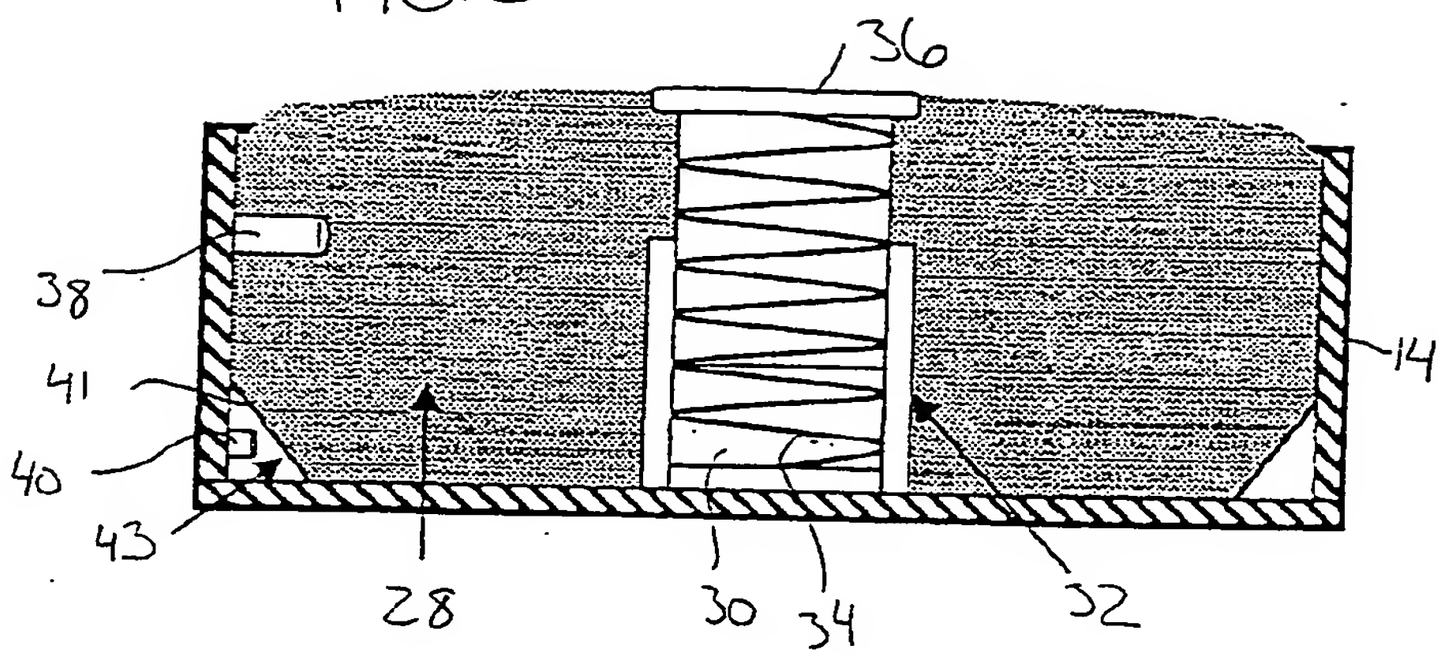


FIG. 6

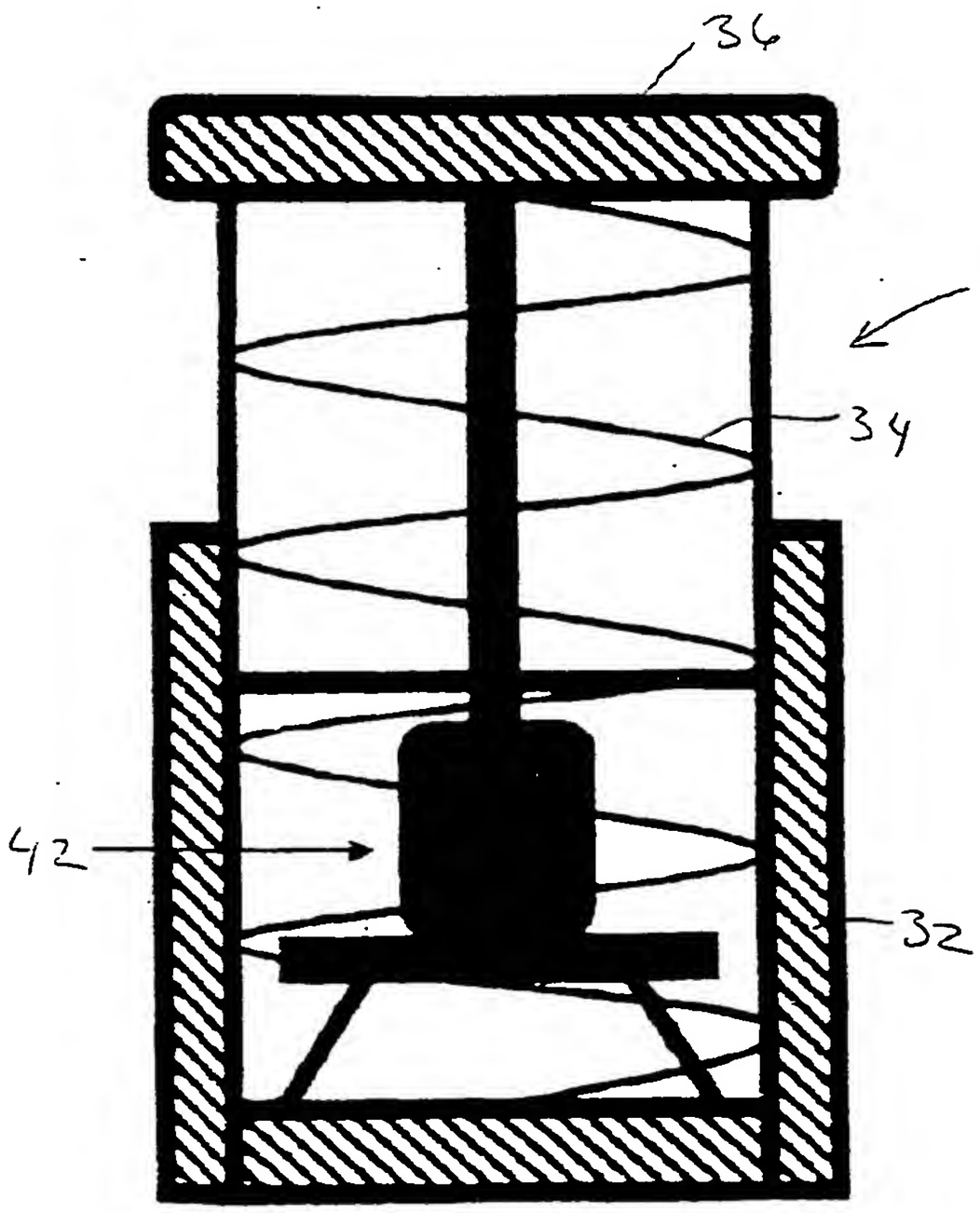
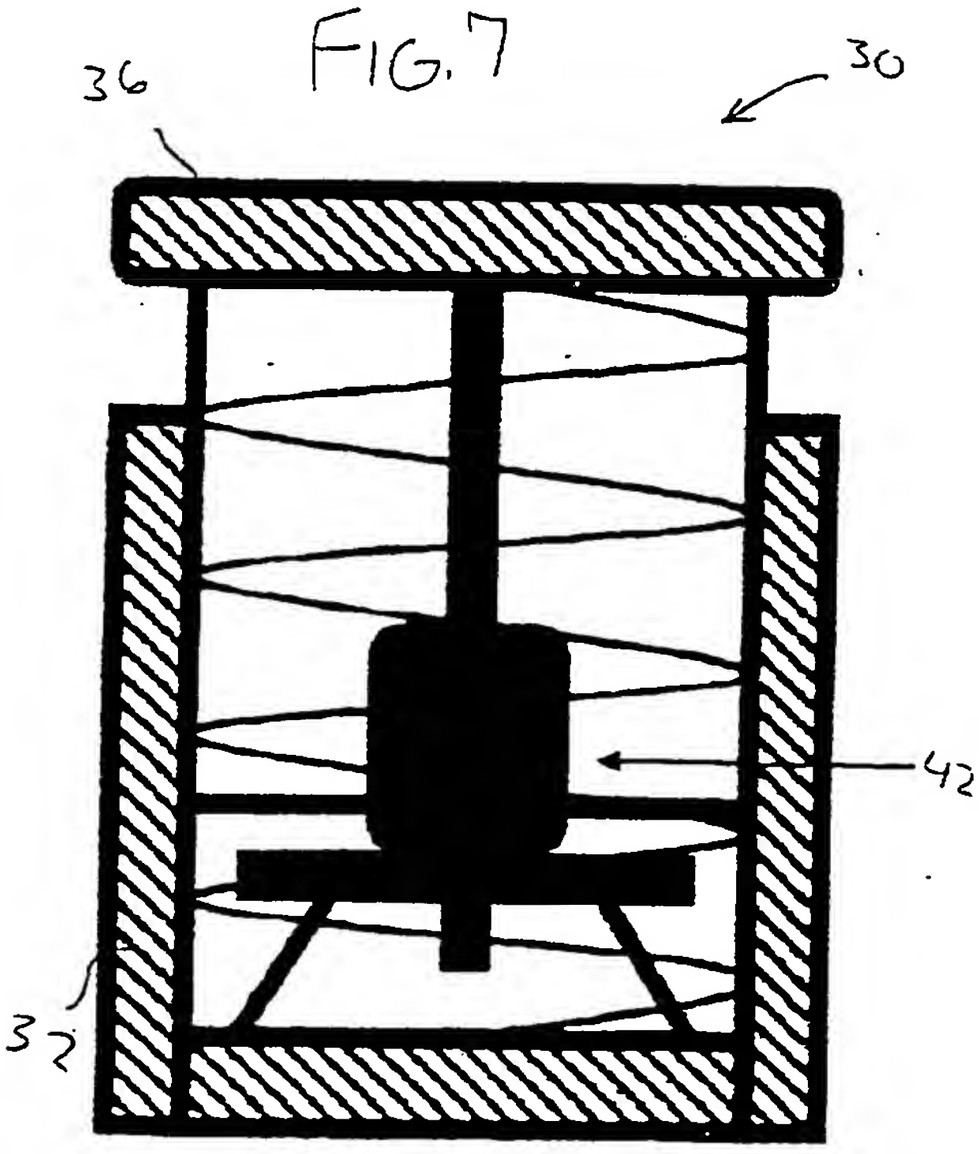


FIG. 7



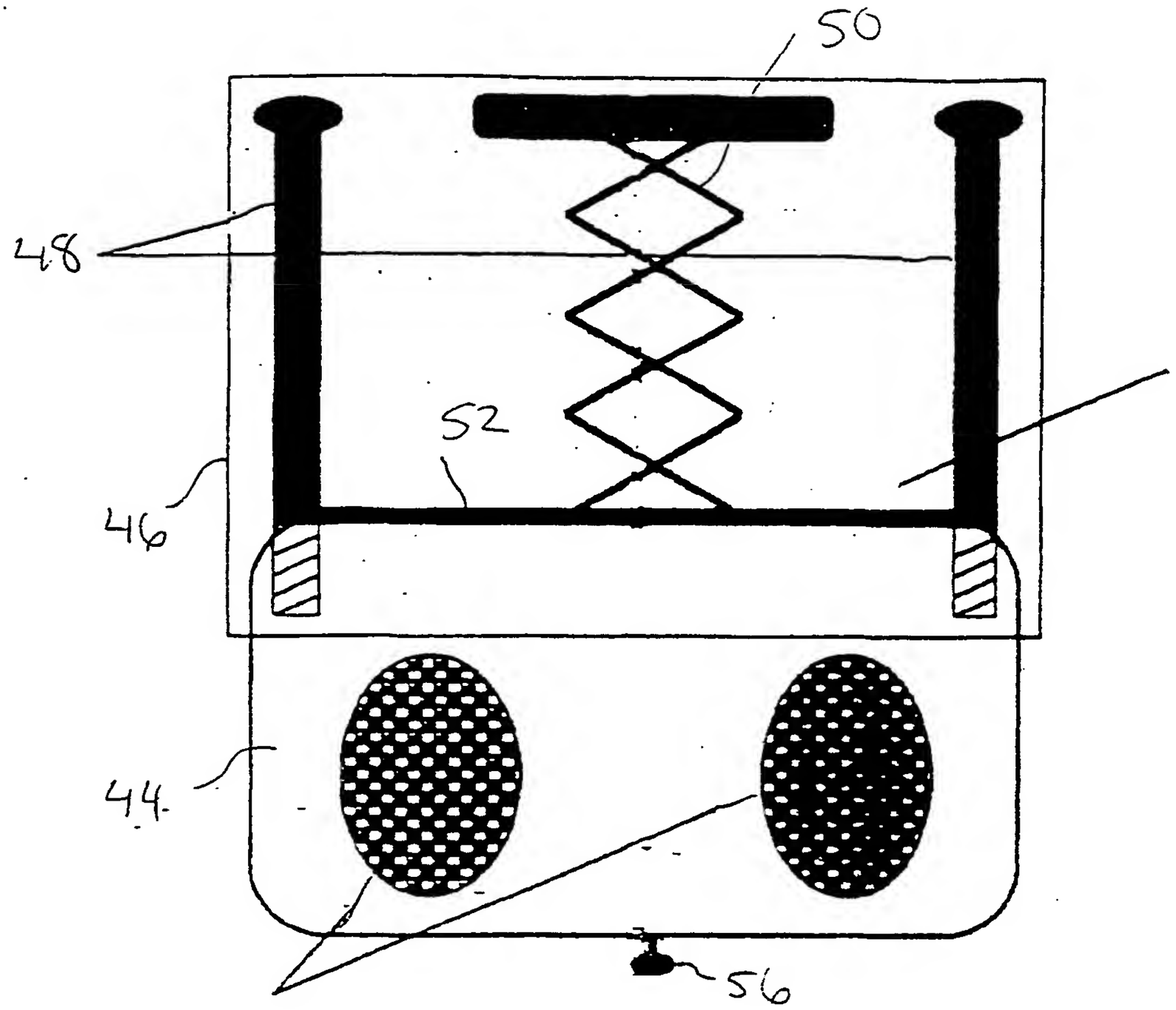


FIG. 8

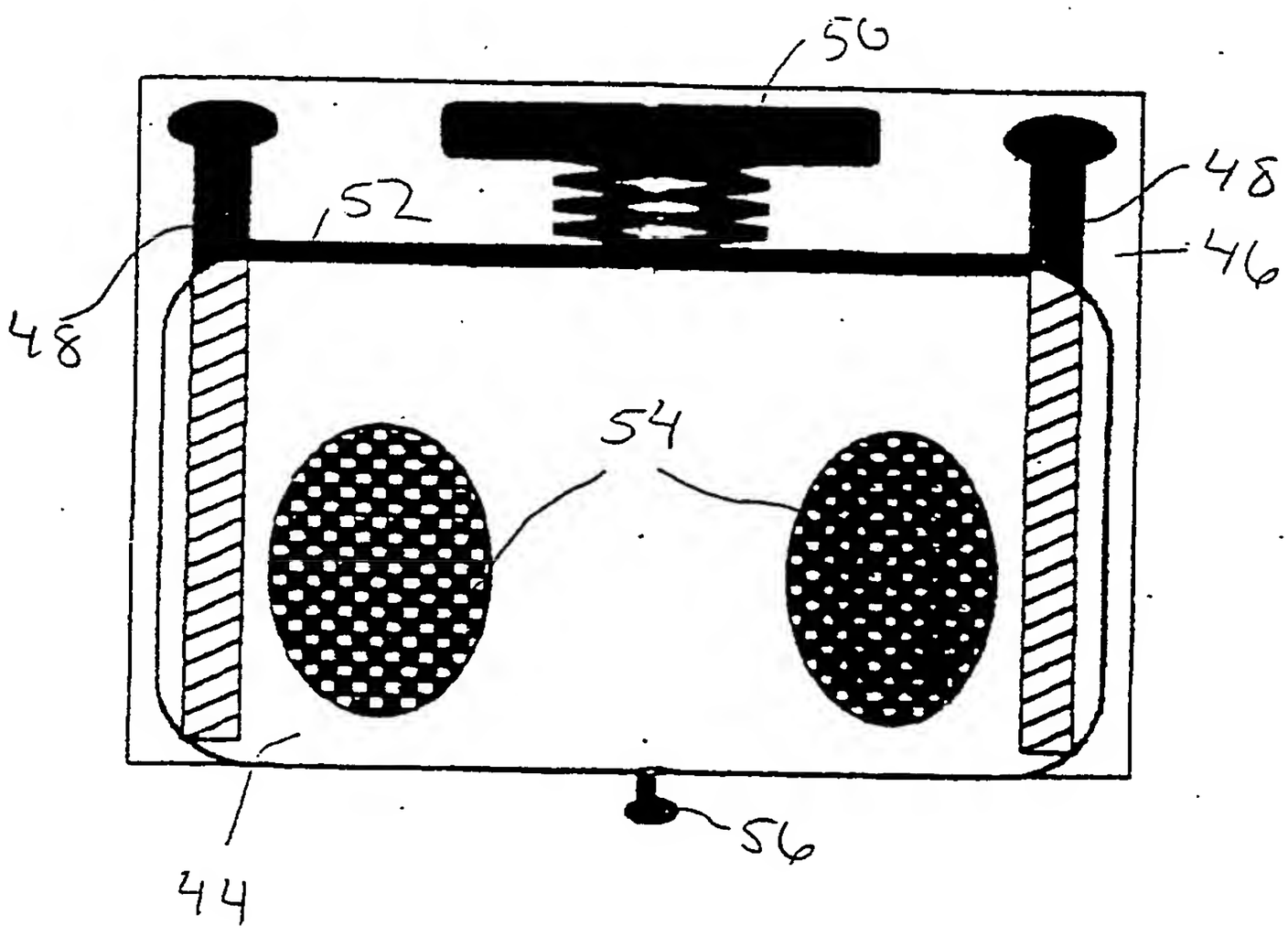


FIG. 9

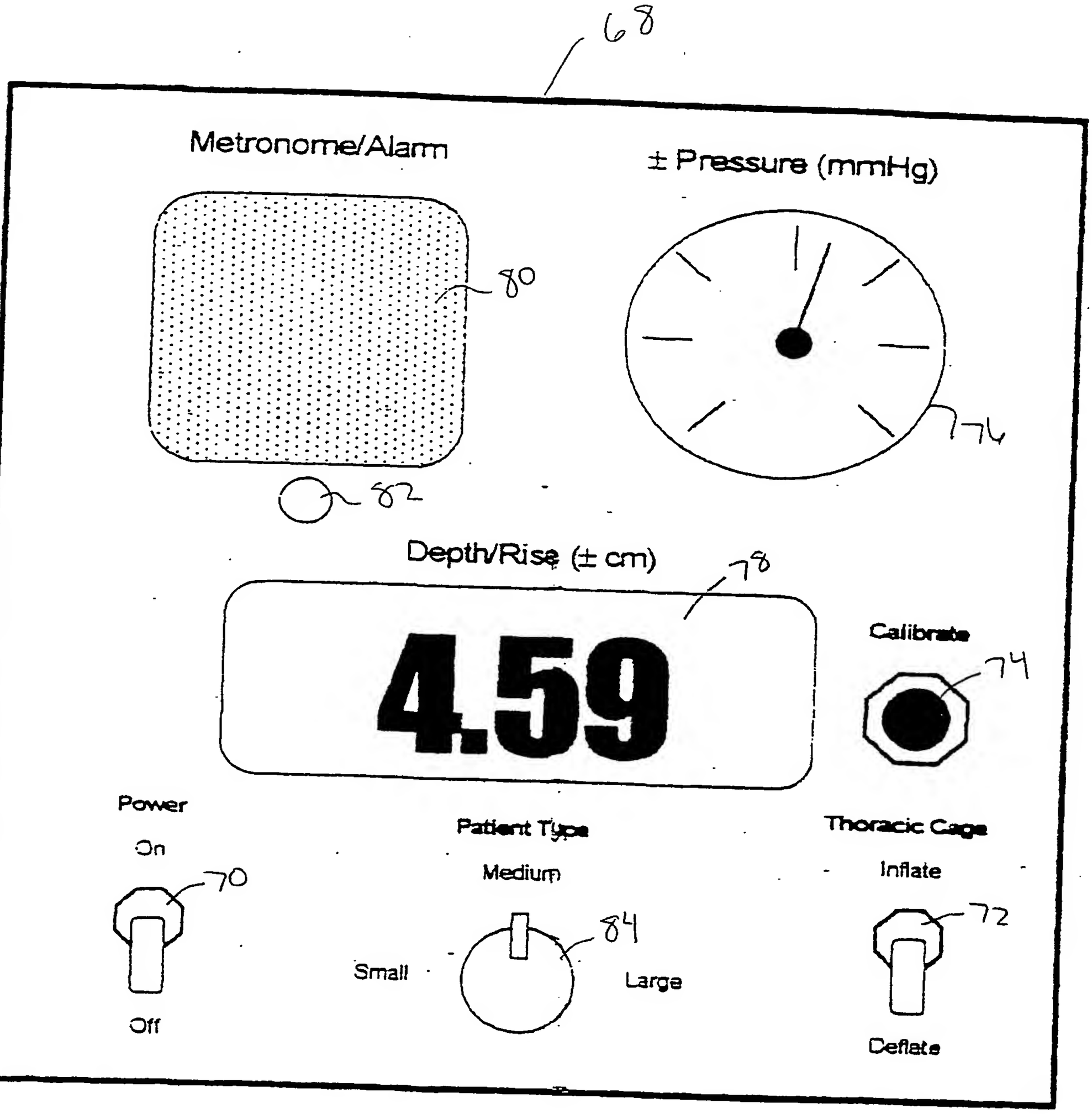

68
Metronome/Alarm
± Pressure (mmHg)
80
82
76
Depth/Rise (± cm)
78
4.59
Calibrate
74
Power
On
70
Off
Patient Type
Medium
84
Small
Large
Thoracic Cage
Inflate
72
Deflate

FIG. 10

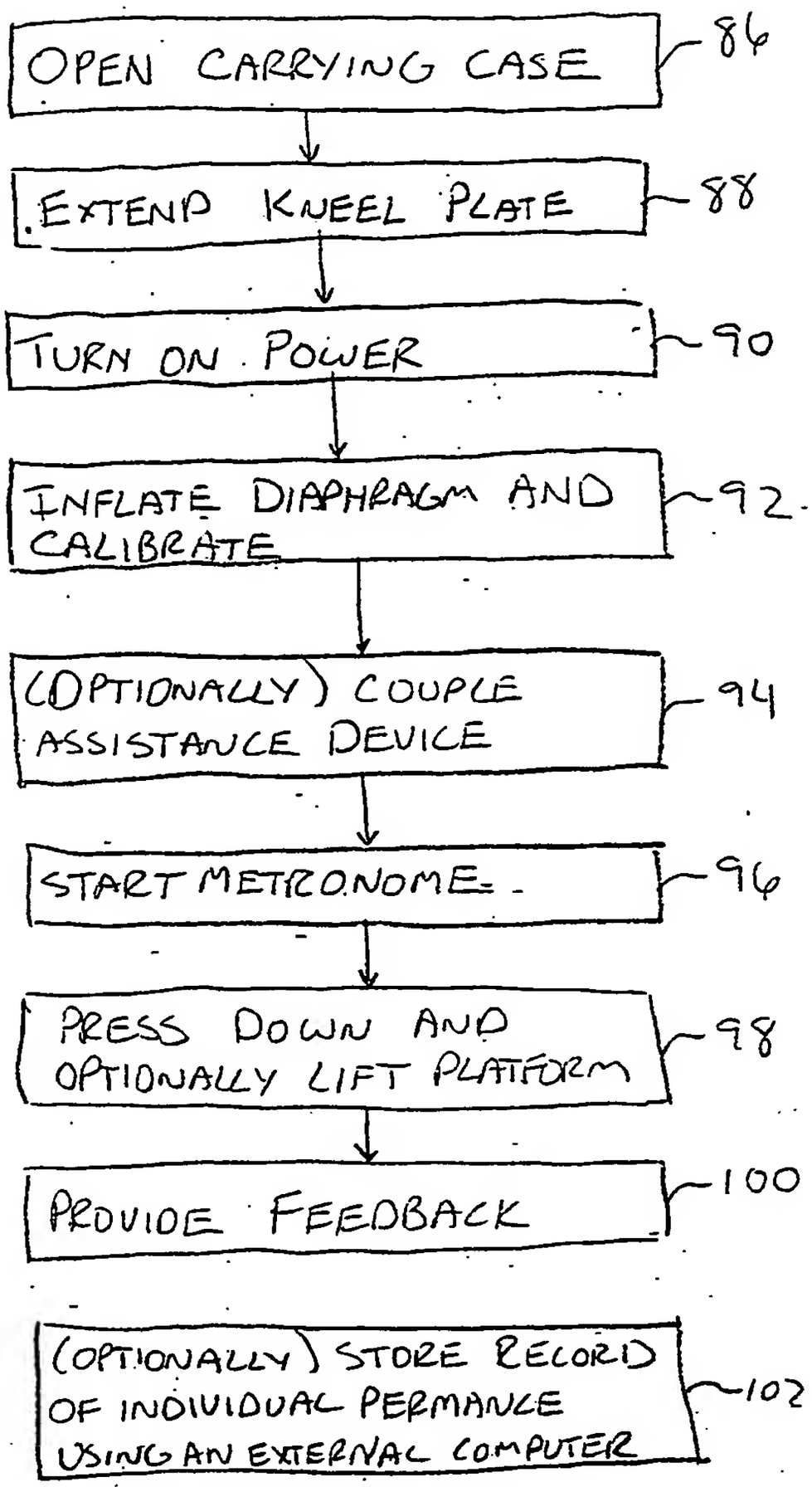

OPEN CARRYING CASE
86
EXTEND KNEEL PLATE
88
TURN ON POWER
90
INFLATE DIAPHRAGM AND CALIBRATE
92
(OPTIONALLY) COUPLE ASSISTANCE DEVICE
94
START METRONOME
96
PRESS DOWN AND OPTIONALLY LIFT PLATFORM
98
PROVIDE FEEDBACK
100
(OPTIONALLY) STORE RECORD OF INDIVIDUAL PERMANCE USING AN EXTERNAL COMPUTER
102

FIG. 11

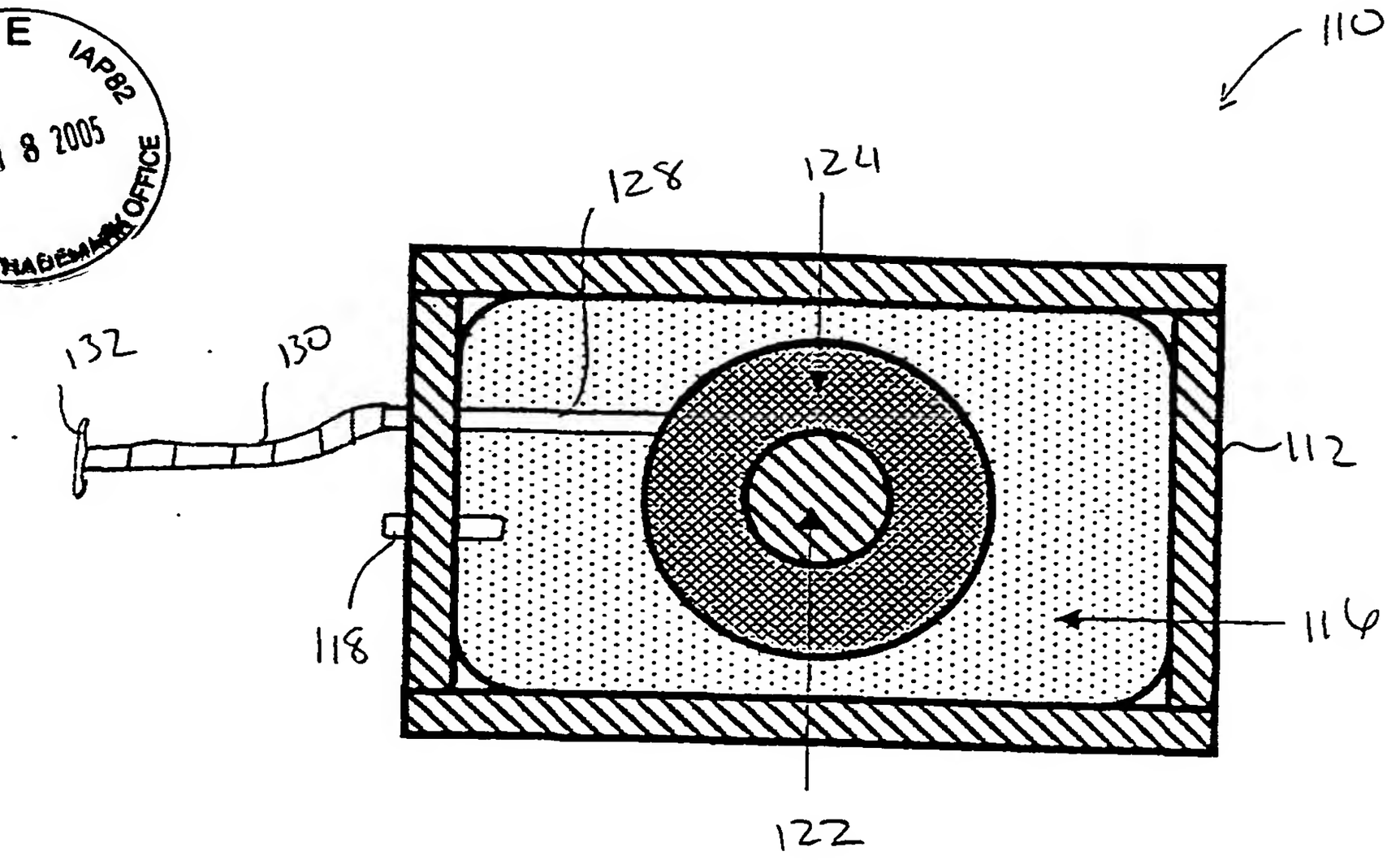


FIG. 12

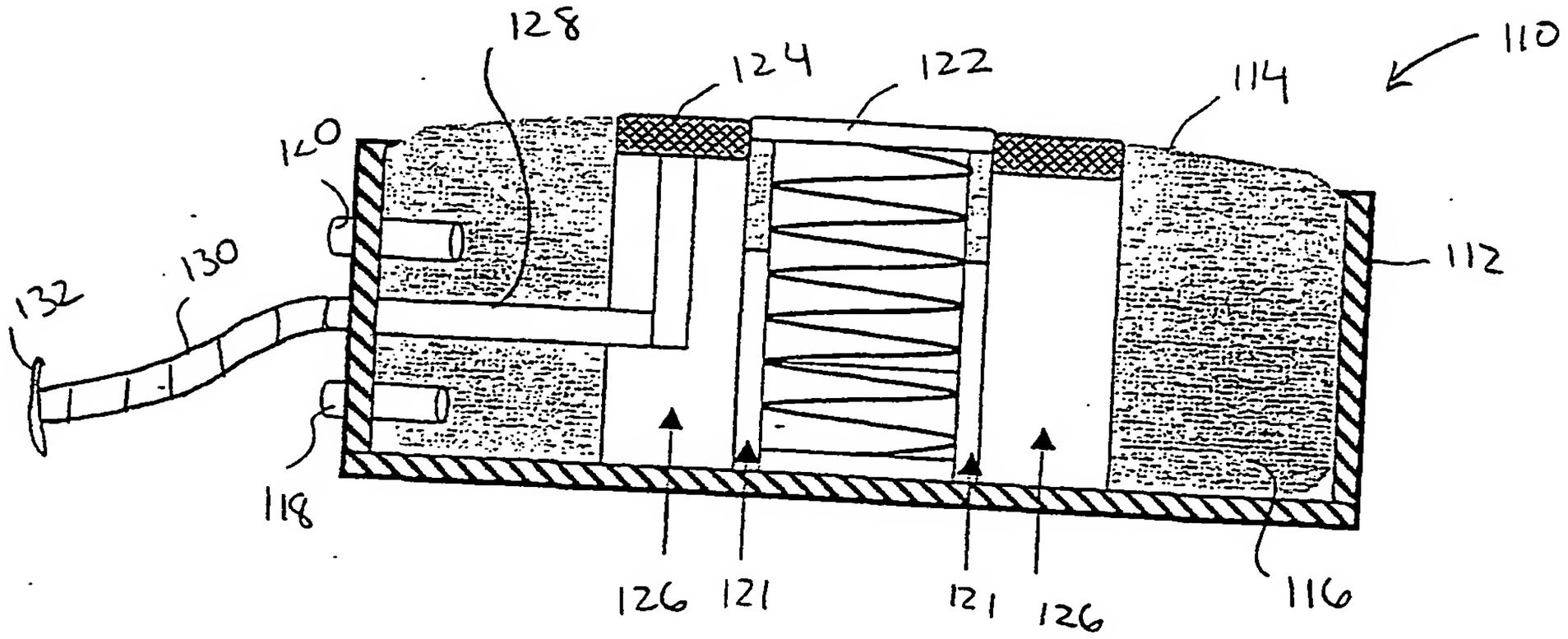


FIG. 13